Name _____Period _____

# Avogadro's Law

## Your Tasks (Mark these off as you go)

- ☐ Define key vocabulary
- ☐ Review the combined gas law
- ☐ Collect your data
- ☐ Investigate the relationship between moles and volume
- ☐ Calculate the ideal gas constant
- ☐ Interpret your results
- ☐ Receive credit for this lab

## ☐ Define key vocabulary

**Avogadro's Law**

**Boyle's Law**

**Charles's Law**

**Gay-Lussac's Law**

**Combined gas law**

**Ideal gas constant**

## □ Review the combined gas law

A gas sample often undergoes simultaneous changes in temperature, pressure, and volume. When this happens, three variables must be dealt with at once. Boyle's law, Charles's law, and Gay-Lussac's law can be combined into a single expression that describes a relationship that is useful in such situations. This relationship, known as the combined gas law, expresses the relationship between pressure, volume, and temperature of a gas when the amount of gas is fixed,

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$P_1$, $V_1$, $T_1$ are the initial pressure, volume, and temperature of the gas respectively.
$P_2$, $V_2$, $T_2$ are the final pressure, volume and temperature of the gas respectively.

Example

A helium filled balloon has volume of 50.0 L at 25°C and 820 mm Hg. What volume will it occupy at 650 mm Hg and 10°C?

Solution

**Step 1**: Identify all the variables which are given in the problem. $P_1$ = 820 mm Hg, $V_1$ = 50.0 L, and $T_1$ = 25°C + 273 = 298 K, $P_2$ = 650 mm Hg, $T_2$ = 10°C + 273 = 283 K

**Step 2:** Identify you unknown. The problem asks for the final pressure, $V_2$

**Step 3:** substitute and solve,

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{(820)(50.0)(283)}{(650)(298)} = 59.9L$$

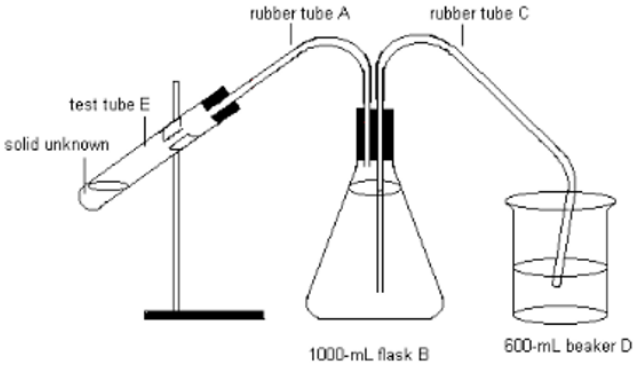
| The volume of a gas is 100.0 mL at 25.0°C and 760. mm Hg pressure. What will be its volume at 15°C and 755 mm Hg pressure? |
|---|
| |

| A 500.0 mL gas sample at STP (STP means standard temperature and pressure: temperature = 273 K and P = 1 atm) is compressed to a volume of 250. mL, and the temperature is increased to 25.0°C. What is the new pressure of the gas? |
|---|
| |

## □ Collect your data

Follow the procedure below to collect your data

1. Fill the large flask with water (the short tube should not be submerged)
2. Connect the stopper and tubes to the jar as shown in the figure below
3. Make sure the clamp on line C is disconnected and check the line for air leaks by blowing air through line A.
4. If water flows freely into the beaker, clamp the tube to stop the flow, then empty the water from the beaker.
5. Mass ~0.1 g of aluminum foil and place this in the test tube. Record this as mass 1.
6. Add about 10 mL of hydrochloric acid (HCl) to the test tube.
7. Quickly secure the test tube to the ring stand disconnect the clamp on line C.
8. Monitor the water collection until all the water level in flask B is just above the long tube. DO NOT let the water drop below the long tube.
9. Once you are done collecting the water, clamp tube C and disconnect the test tube.
10. Transfer the water you collected into a graduated cylinder and record the volume.
11. Repeat the above for the amounts of foil indicated below.
12. Record the temperature of your water.



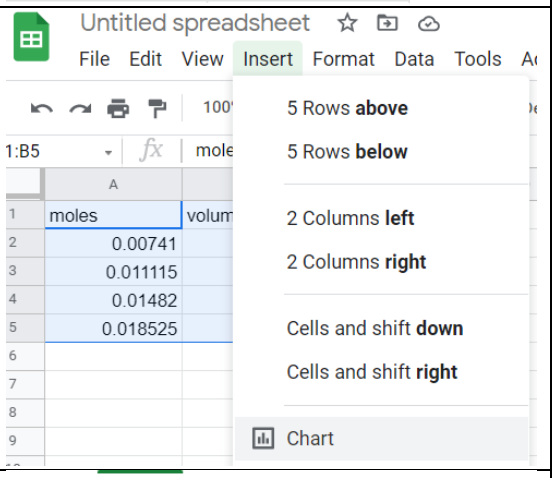
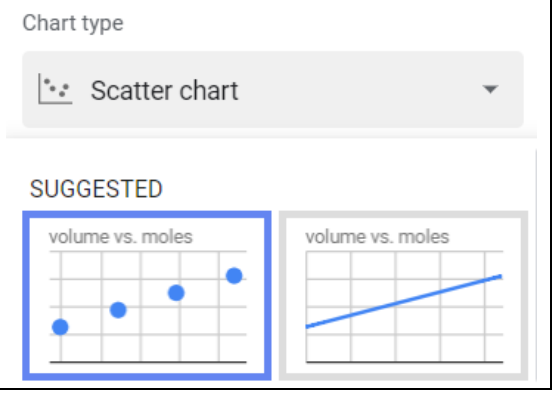

**Data table**

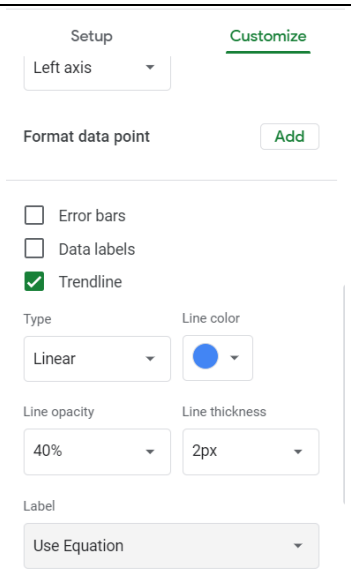
| Foil | Actual amount of foil used (g) | Moles of foil | Volume of water collected (mL) | Volume of water in Liters |
|---|---|---|---|---|
| 0.1 g | | | | |
| 0.15 g | | | | |
| 0.20 g | | | | |
| 0.25 g | | | | |
| Temperature of water (Celsius) | | | | |
| Temperature of water (Kelvin) | | | | |

Observations

## ☐ Investigate the relationship between moles and volume

- For each quantity of aluminum that you used, calculate the corresponding moles. Record this amount in the data table above.
- For each quantity of water you collected, calculate the corresponding value in Liters. Record this amount in the data table above.
- Convert your temperature in Celsius to Kelvin

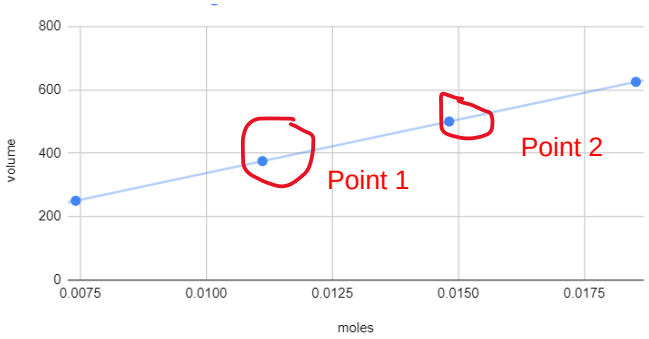
| | |
|---|---|
| Open Google Sheets<br>Type “moles Al” in cell A1<br>Type “volume” in cell A2 | moles: 0.00741, 0.011115, 0.01482, 0.018525<br>volume: 250, 375, 500, 625 |
| Enter your data into the appropriate columns<br>Select everything and select Insert, then Chart from the top menu |  |
| Select Scatter chart from the chart type |  |

| | |
|---|---|
| Select the Customize tab. Locate and click the Trendline option.<br><br>Locate and select the Use Equation option<br><br>Insert your graph in the space below. |  |

| Insert your graph below |
|---|
| |

## ☐ Analyze your data

Consider the graph and the points shown. Write an equation that relates the slope at point 1 to the slope at point 2.



## ☐ Calculate the ideal gas constant

Assume the pressure during the experiment was 1 atm calculate the value of the following at all points on your graph. **You must use the volume in Liters and the temperature in Kelvin**!

| | **PV/nT** |
|---|---|
| **Point 1** | |
| **Point 2** | |
| **Point 3** | |
| **Point 4** | |

## ☐ Interpret your results

Answer the following in <u>complete sentences</u>. You must also be mindful of spelling, punctuation and overall writing quality.

What was the purpose of this experiment?

In your own words, summarize what you did to accomplish the purpose.

Observe your graph. Is the relationship between moles and volume direct or indirect.

If the slope is rise over run, write an equation in terms of moles and volume that could be used to calculate the slope of your graph.

Is the value of PV/nT the same at all points? Should it be? Explain.

## □ Receive Credit for this lab

Each group member must complete and submit their own lab to receive credit